What we have to do for Responsible Data Science?

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1. Introduction

Increasing data volume has changed the way research, governance, socialization, and business are being conducted (HILBERT; LÓPEZ, 2011, KEMPER; KOLKMAN, 2018). This data is generated by different segments of society, government, industry, research institutes, and universities. How they are collected, stored, and disseminated is also carried out in different ways and by different bodies (EUROPEAN DATA SCIENCE ACADEMY, 2019; STOYANOVICH; HOWE, 2018; TAYLOR, 2017b). Investments, whether financial or human resources have

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been made in data science, artificial intelligence, and data technologies. In parallel to this, there is a concern shared by society, governments, and researchers regarding the responsible use of data.

For Kemper & Kolkman (2018, p. 5),

> Data science can only be effective if people trust the results and can correctly infer and interpret the outcomes. Data Science should thus not be viewed as a black box that magically transforms data into value. Many design choices need to be made in a typical 'data science pipeline' [...].

Recent examples of data collection, treatment, and use have been widely reported: the use of digital and bibliometric record data by India and China to track and monitor citizens (TAYLOR, 2017b); the collection of Facebook personal data used for political purposes without users' consent by Cambridge Analytica (FACEBOOK, 2019). Actions such as these warn against the use and publication of data without respect for privacy or leading to unfair and/or biased conclusions from different citizens (AIMS, 2017; OHM, 2014; TAYLOR, 2017b).

The current landscape shows that companies make profits, governments influence decision making concerning their citizens and people are induced into concepts based on data that are not imbibed with the principles of ethics and justice (STOYANOVICH; HOWE, 2018; TAYLOR, 2017b).

Amid this problem arises, as strong demand, the application of individual and corporate rights and rules that safeguard the

privacy of the individual and the transparency of information (MOEREL; PRINS, 2016). In this sense, the Responsible Data Science (RDS) project arises, presented as a possibility to address issues regarding impartiality, accuracy, reliability, and transparency, regarding Big Data and Data Science. These four principles are represented by the acronym FACT (Fairness, Accuracy, Confidentiality, Transparency) (VAN DER AALST, 2016).

RDS seeks to develop methods and techniques to support the publication and use of data following the FACT, to provide technology to ensure these principles at the development stage, and to create multidisciplinary platforms. The adoption of FACT, still in the conception phase of the technologies and methods applied to Big Data and Data Science, is an alternative to guarantee the quality and security of data use (STOYANOVICH; HOWE, 2018; VAN DER AALST, 2016).

In view of the challenges of the fair and sustainable incorporation of ethical values into individual rights, the technological innovations involving Data Science and the potential benefits of the effort to meet new global challenges that the whole of humanity is engaged in, this study analyses the FACT guidelines.

This work is descriptive research in which the bibliographic search was performed from the Scopus and Web of Science databases and with the Google Scholar search engine. The documentary research was developed on websites of

organizations that address the present theme: Responsible Data Science, Data Science Center Eindhoven, and GE 301-Group 7. The searches were conducted using the terms "Responsible Data Science", "Fairness, Accuracy, Confidentiality, Transparency + Data Science", FACT + Data Science; FAIR + FACT.

This article is structured in four sections: Introduction, Section 1, where the theme is presented; Section 2, which contains a literature review around Responsible Data Science and the FACT; The discussions in Section 4; and, in the end, the Final Considerations and References.

2. Literature review

For Mayo (1996) and Chalmers (2013), cited by Van der Aalst (2016), in the context of the Web, there is a change in the way knowledge is generated. When knowledge is based on data, [...] follows the logic of the new experimentalism, in which knowledge is derived from experimental observations, not theory. In this new paradigm, concerns arise about data, especially how data may be used irresponsibly.

A group of researchers from different institutions in the Netherlands has started a new precept: RDS which, according to van der Aalst (2016), aims to produce positive solutions rather than avoiding the use of data. The RDS consortium was launched in 2016 with the aim of "[...] tackling ethical and legal challenges, and developing data science techniques, infrastructures, and approaches that are responsible for fair, accurate processes and

confidential, design-transparent data" (AIMS, 2017; MOEREL; PRINS, 2016).

This initiative involves disciplines such as data mining, digital humanities, ethics, information retrieval, knowledge representation, law, machine learning, natural language processing, security, statistics, and visualization (VAN DER AALST, 2016; VAN DER AALST; BICHLER; HEINZL, 2017) and can be applied to the media, safety and health domains.

For the European Academy of Data Science[3], "The 'Data Age' produces exponentially diverse data whose challenges relate to the collection, storage, and analysis of these data". In this environment, powerful techniques such as data mining, machine learning, database, and visualization have been developed that aim to improve people's lives by offering new services and products with higher quality and efficiency (GE 301 GROUP 7, 2017; STOYANOVICH et al., 2017; STOYANOVICH; HOWE; JAGADISH, 2018).

In Piersman's (2018) view, RDS "[...] is one of the foundations of digital transformation" and can contribute to the enforcement of the United Nations Sustainable Development Goals (PAPPALARDO; GROSSI; PEDRESSHI, 2021). Consequently, there is a need to adopt guidelines towards Responsible Data Science. According to Pappalardo, Grossi e Pedreschi (2021, p. 261), "Social Mining and Big Data Ecosystems for Open, Responsible Data Science are necessary,

3 EDSA Project. See: http://edsa-project.eu/overview/aboutedsa/. Access: 20 oct. 2021

which not only strengthen the existing clusters of excellence in social data mining research but also strive at creating global, interdisciplinary communities of social data scientists, fostered by extensive training, networking, and innovation activities[4].

Although initiatives such as the mentioned above are encouraging, however, reality shows that automatic data decisions may be unfair and not transparent; confidential data may be unintentionally shared or misused by a third party; inaccuracies can be generated from the incorporation of biases by algorithms, among other problems (OHM, 2014; STOYANOVICH & HOWE, 2018). These facts cause great concern regarding the production and use of data, namely regarding false information, biased conclusions, disclosure of private and non-transparent information, which may hinder the application of scientific data (AIMS, 2017), for example, or compromise the safety of people and the personal and professional life of the individual (GE 301 GROUP 7, 2017; OHM, 2014; TAYLOR, 2017; TAYLOR; PURTOVA, 2019).

Richard and King (2014), referenced by Lodder (2016), professor at Vrije Universiteit, Amsterdam, considers that the construction of this new digital society, which he calls Big Data Society, and the balance of human values such as privacy, confidentiality, transparency, identity, free will, associated with new digital structures, will impact on the construction of individuals. In this sense, it warns about the importance of

4 Social Big Data. See: http://www.sobigdata.eu/index. Access: 20 oct. 2021.

preserving these values for the benefit of innovation and convenience.

These values are reiterated by the RDS initiative which, as outlined, aims to develop a sustainable model for data science based on ethical values and the application of techniques under the requirements of impartiality, accountability, transparency, and confidentiality by conception (DATA SCIENCE CENTER EINDHOVEN, 2018).

For the Data Science Center Eindhoven Research Program,

> […] societal values are an intrinsic part of the value of big data. Building values into data science 'by design' is a challenging and fascinating interdisciplinary field of research with many practical applications […]. Creating societal value through data science requires an understanding of context and effective governance of data! (DATA SCIENCE CENTER EINDHOVEN, 2018).

Thus, Research Data Science emerges based on four pillars – impartiality, accuracy, confidentiality, and transparency, represented by the FACT acronym – to address issues that affect society in different ethical, economic, and/or social aspects.

Tayla and Purtova (2019) bring light to the lack of clarity regarding the concept of Responsible Data Science when applied to the various contexts, which according to the authors may cause difficulties establishing goals and limits for the scientific practice of the data. Therefore the motivation to explore FACT principles.

These principles can be defined as follows:

a) **Fairness**: The term is defined as being the attitude of those who consider, objectively, without passions or prejudices, a certain fact in all its aspects. Those who are impartial do not sacrifice truth and justice for the convenience or convenience of others for personal gain, nor do they weigh in the judgment previous facts or information that may harm or favor them individually (ÁVILA, 1967). By way of impartiality, fairness of data, Taylor (2017a, p. 1) states that the availability of digital data, especially from the use of technological devices and services by people, "[...] has political and practical implications for the way people are treated by the community, the state, and the private sector". However, the level of awareness and implementation of mechanisms that combat potential discrimination is lower compared to the speed with which data processing technologies are developed.

b) **Accuracy**: Accuracy of information or measurement is its quality of being true or correct, even in small details (ACCURACY..., 2019). The production of inaccurate results is independent of the amount of data analyzed. Variables are used to predict a result. For this, there must be a positive or negative correlation between variables and results to obtain better accuracy (GE 301 GROUP 7, 2017).

c) **Confidentiality**: It is considered a duty to safeguard all information that concerns a person, that is, their privacy. Confidentiality includes the preservation of private and intimate information (GOLDIM, 1997).
d) **Transparency**: It means "[…] that all codes and all data must be public" (STOYANOVICH et al., 2018, p. 2165) and is seen as a requirement for algorithmic accountability.

Annany e Crawford (2016) suggest that transparency cannot be a characteristic of an algorithmic model. Rather the opacity of algorithms should be considered with a sensitivity for the contexts of their use; transparency is performed by socio-technical assemblages of algorithms and people. However, transparency is not always complete, either because of guarantees associated with commercial rights or because of the privacy of citizens who, if not respected, violate the laws (STOYANOVICH et al., 2018).

The principles cited here are upheld by the RDS and are associated with the legality, the normative, and the ethical that, in addition to the FAIR principles (Findability, Accessibility, Interoperability, and Reusability), appear as the main research subjects in Big Data. It should be noted that the FACT guidelines, although not covered, are complementary to FAIR, mainly because they focus on essential aspects of fairness and data re-use.

The discussion on FAIR has involved professionals and institutions from different domains and is in a more advanced stage, therefore with more publications. Regarding the FACT guidelines, because they have been presented recently or because the actors working in the area do not understand the dimension of these elements, they have not reached the same level of discussion, although their implications involve society in a more present and impacting way. Advocates of the FACT guidelines emphasize that they should be applied not only in the use of algorithmic models but also in the design and development phases.

FACT handles methodological issues for the management of data, which point out the risks in the Big Data analysis and the concern with preparing and ensuring the data so that responsibility and ethics can be verified.

3. Discussion

The RDS initiative represents a group that looks for alternatives to the implementation of FACT and the actions in search of results are contemplated by Green Data Science, a term coined by one of the founders of the RDS group.

Although of unparalleled importance for answering questions related to ethics, economics, and social aspects, the signaling of FACT guidelines in the literature is still timid. In the articles consulted, transparency is the principle most commented on by most articles consulted, which denotes the concern of the authors with the society's demand on the subject, closely related

to the public availability of data. The principle of confidentiality was the second most addressed, followed by impartiality and precision. In analyzing these results, we note that there are difficulties in adopting the principles equally and effectively. Examples are actions that, while preserving confidentiality and impartiality, affect levels of transparency.

According to Taylor e Purtova (2019), these principles are far from informing a coherent system of norms and standards concerning data governance. The position of Kemper e Kolkman (2018) is that there should be more empirical studies on algorithmic models to test algorithmic responsibility, because only then will it be possible to develop sound guidelines appropriate to existing practices. This should be a major challenge, as the existence of legislation does not guarantee the effectiveness of the use of these principles (MOEREL, 2016; OHM, 2014).

For Ohm (2014), most privacy laws focus on collection and disclosure, not use. On the other hand, there are still differences in laws from one country to another. United States privacy law is different from the European Union Data Protection Directive, even when it comes to aspects whose damage may be global. The rule that data must be processed for a specific purpose and subsequently used or communicated only to the extent that it is not incompatible with the usefulness of the transfer also seems intangible. Working with big data is working with the unpredictable. So, how to ensure the final result of data analysis?

Questioning motivates discussion and investigation in the data universe.

On the other hand, professionals such as analysts, programmers, data scientists, information scientists and the government play a vital role in safeguarding these principles to promote an egalitarian society. As stated in this study, actions to ensure the four principles are designed more slowly than technologies developed for data analysis and dissemination.

In addition to the proposals identified by the study, the theme still requires a great joint and interdisciplinary effort from social and technological areas so that they can happen actually.

In the age of liquid society, where everything dissolves - following Bauman's concept – and where each individual is a producer, diffuser, and advocate of his idiosyncrasies, which takes for truth and proclaims them, the reliability of information has acquired a kind of own quotation, a valuation that varies according to the capacity of the individual who needs it, which, for higher levels of intellectual education, even opens the way for a new professional: the one who investigates, checks and makes available, considered reliable, attending to the consumer's needs of this reliability.

Observing the historical period that precedes this phase, called Bauman (2001) "solid modernity", the author presents ideas that point out constancy and security, because the transformation of values occurred slowly and noticeably, giving

the sensation of certainty and certainty. control over what was happening in the world.

Thus, when we consider, through this approach of liquid modernity, the directions that most denote the social side, we find that they may be more complex, especially in matters of data discrimination and sensitivity. According to the initiatives that show how RDS technology is being worked, it is inferred that data processing systems demand greater flexibility to adapt to the vertiginous changes in direction caused by the flow resulting from the pressure exerted. conditions common to "net life" (BAUMAN, 2001).

4. Conclusion

The concept of RDS presents a significant advance in the context of Big Data and Data Science, bringing important elements that favor reflection by data and information scientists. In particular, FACT identifies the aspects and facets linked to this concept, as well as demonstrating what these actors should consider during the processes that make up the phases of the Data Lifecycle.

We note that the actions promoted by the RDS group concerning FACT guidelines can contribute to safeguarding individual rights without the need for measures that summarily prevent access and reuse of data.

Thus, we emphasize that data analysis techniques, together with semantic technologies, have been widely used from a technical perspective, aiming to generate value for organizations.

In this sense, the study and approach of the social sciences to these themes are relevant for social issues to be considered during technological processes. While there are relevant moves to pass laws that guarantee individual rights in the context of Big Data, the use of technology is imperative for these rights to be secured.

Given the above, there is a need for empirical studies on algorithm models, in which FACT principles are analyzed in practice, so that those involved in data generation, storage, and processing adopt mechanisms that assure them confidence in the services provided, as well as the data accessed.

The development of such data analysis technology according to the FACT model of Responsible Data Science approach is of crucial importance because failure to implement this approach in data technologies can result in undesirable consequences for society. impacting on three elements: privacy, security, and responsibility. It should be noted that the four FACT principles will hardly be contemplated simultaneously, however, a balance should be sought in which compensations are considered to prioritize one over the other(s). If confidentiality is ensured, accuracy and transparency are likely to be compromised. Therefore, the search for a balance between these four principles should be pursued by both developers and data managers.

Referências

ACCURACY. **Collins dictionary**. See: https://www.collinsdictionary.com/pt/dictionary/english/accuracy. Access: 29 may. 2021.

AIMS. **Responsible data science. Ensuring, fairness, accuracy, confidentially, transparency**. 2017. See: http://aims.fao.org/news/responsible-data-science-ensuring-fairness-accuracy-confidentially-transparency-fact. Access: 29 may. 2021.

ANNANY, M.; CRAWFORD, K. Seeing without knowing: limitations of the transparency ideal and its application to algorithmic accountability. **New Media & Soc**., v. 20*,* n.3, p. 973–989. 2016.

ÁVILA, F. B. S. J. **Pequena enciclopédia de moral e civismo**. Rio de Janeiro: MEC, 1967.

BAURMAN, Z. **Modernidade líquida**. Rio de Janeiro: Zahar, 2001.

DATA SCIENCE CENTER EINDHOVEN. **Responsible Data Science:** Ensuring fairness, accuracy, confidentiality & transparency by design. DSCE, 2019. See: https://www.tue.nl/en/research/research-areas/data-science/responsible-data-science/. Access: 10 jan. 2019.

EUROPEAN DATA SCIENCE ACADEMY. **About EDSA**. 2019. See: http://edsa-project.eu/overview/about-edsa/. Access: 28 jan. 2019.

FACEBOOK: Cambridge analytica data scandal. **Wikipedia:** The Free Encyclopedia. See: https://en.wikipedia.org/wiki/Facebook%E2%80%93Cambridge_Analytica_data_scandal#:~:text=The%20Facebook%E2%80%93Cambridge%20Analytica%20data,be%20used%20for%20political%20advertising.&text=The%20app%20harvested%20the%20data%20of%20up%20to%2087%20million%20Facebook%20profiles. Access: 26 apr. 2019.

GE 301 GROUP 7**. Responsible Data Science**. 2017. See: http://ge301.bilkent.edu.tr/fall2017group7/. Access: 25 may. 2021

GOLDIM, J. R. **Confidencialidade** (1997-2003). See: https://www.ufrgs.br/bioetica/confiden.htm. Access: 15 mar. 2019.

HILBERT, M., LÓPEZ, P. The world's technological capacity to store, communicate, and compute information. **Sciencexpress**, p. 1-7, 2011. See: https://www.ris.org/uploadi/editor/1304938275129769729 4Science-2011-Hilbert-science.1200970.pdf. Access: 18 mar. 2019.

KEMPER, J., KOLKMAN, D. Transparent to whom? No algorithmic accountability without a critical audience. **Inf. Commun. Soc***.,* v.14, 1–16, 2018.

LODDER, G. M. A., SCHOLTER, R. H. J., GOOSSENS, L., ENGELS, R. C. M. E., VERHAGEN, M. Loneliness and the social monitoring system: emotion recognition and eye gaze in a real-life conversation. **Br. J. Psychol**, v. 107, n. 1, p. 135-153, 2016.

MOEREL, L. **GDPR conundrums**: the data protection officer requirement. 2016. See: https://fdocuments.in/document/gdpr-conundrums-the-data-protection-officer-requirement-mediafilesarticles201607160719gdprgdpr. Access: 10 jan. 2019.

MOEREL, E. M. L., PRINS, C. **Privacy for the homo digitalis: proposal for a new regulatory framework for data protection in the light of Big Data and the Internet of Things**. 2016. See: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2784123. Access: 10 jan. 2019.

OHM, P. Changing the rules: general principles for data use and analysis. In: Lane, J., Stodden, V., Bender, S., & Nissenbaum, H. (Ed.). **Privacy, big data, and the public good:** frameworks for engagement. Cambridge: Cambridge University Press. v.1, p. 96-111, 2014.

PAPPALARDO, L.; GROSSI, V.; PEDRESCHI, D. Introduction to the special issue on social mining and big data ecosystem for open, responsible data science. **International Journal of Data Science and Analytics**. v. 11, p.261-262, 2021.

PIERSMA, N. Data in urban environments. In: PIERSMA, N. (Ed.). **Through the clouds:** urban analytics for smart cities. Amsterdam: Hogeschool van Amsterdam. p. 11-21, 2018.

STOYANOVICH, J., HOWE, B. **Follow the data!** Algorithmic transparency starts with data transparency, 2018. See: https://ai.shorensteincenter.org/ideas/2018/11/26/follow-the-data-algorithmic-transparency-starts-with-data-transparency. Access: 21 mar. 2019.

STOYANOVICH, J., HOWE, B., JAGADISH, H. V. Special Session: A technical research agenda in data ethics and responsible data management. **In *Proceedings…* International Conference on Management of Data**, p. 1635–1636, 2018. See: https://dl.acm.org/doi/10.1145/3183713.3205185. Access: 23 mar. 2021.

STOYANOVICH, J., HOWE, B., ABITEBOUL, S., MIKLAU, G., SAHUGUET, A., WEIKUM, G. (2017). Fides: Towards a platform for responsible data science. In SSDBM'17. **29th International Conference on Scientific and Statistical Database Management**, 2017, Chicago, United States. See: https://hal.inria.fr/hal-01522418/document. Access: 10 jan. 2019.

STOYANOVICH, J., HOWE, B., JAGADISH, H. V., MIKLAU, G. Panel: a debate on data and algorithmic ethics. **Proceedings of the VLDB Endowment**, v.11, n.12, p. 2165–7,

2018. See: https://dl.acm.org/doi/10.14778/3229863.3240494 Access: 14 abr. 2019.

TAYLOR, L. **Data, visibility and justice**, 2017a. See: https://redasci.org/wp-content/uploads/2016/10/Linnet-Taylor-RDS-16.3.17.pdf. Access: 22 feb. 2021.

TAYLOR, L. What is data justice? The case for connecting digital rights and freedoms globally. **Big Data & Society**. p. 1-14, 2017b.

TAYLOR, L., & PURTOVA, N. What is responsible and sustainable data science? **Big Data & Society**, v.*6*, n. 2, 2019.

VAN DER AALST, W. M. Green data science: using big data in an "environmentally friendly" manner. **In 18th International Conference on Enterprise Information Systems (ICEIS 2016)**. p. 25-28, 2016. Rome: SciTePress.

VAN DER AALST, W. M., BICHLER, M., & HEINZL, A. Responsible data science. Bus. **Inf. Syst. Eng**. v. 59 n. 5: p. 311–313, 2017.